CCNPP Intake Structure Repair and Cathodic Repair Project

Lusby, Maryland

Submitted by Structural Preservation Systems

Calvert Cliffs Nuclear Power Plant

Built by Baltimore Gas & Electric in the 1970s, the Calvert Cliffs Nuclear Power Plant (CCNPP) and its associated high-power electric lines are a Calvert County landmark. The facility has two nuclear reactors. Unit 1 began generating electricity in 1975 and Unit 2 joined the system in 1977.

In March 2000, CCNPP opened a new chapter in nuclear power history by becoming the first plant in the U.S. to earn 20-year extensions of its operating licenses from the U.S. Nuclear Regulatory Commission (NRC). CCNPP replaced the steam generators in Units 1 and 2.

Deterioration Becomes a Problem

When deterioration of steel on the intake floor, circular water pump bowels (CWB), and salt water pits (SWP) became severe, CCNPP contacted a concrete repair contractor for assistance. The owner wanted to repair the concrete surfaces with a system that would help prevent corrosion and last for a period of approximately 20 years to reduce plant maintenance costs.

Approximately 1 year prior to contracting the project, an independent engineering firm performed initial inspections of the three areas—CWB, SWP, and the main floor. Sounding determined the amount of deterioration. From this information, it was decided that the best repair procedure for the main floor was to remove an average of 6 in. (150 mm) of the existing concrete to remove all delaminations, as well as the concrete that had a high calcium content.

Several factors contributed to the deterioration of the concrete. First was the constant exposure to salt water that inundated the system for three decades. The second cause of deterioration was the fact that several pieces of large electrical equipment were grounded to the slab, sending stray currents through the concrete (these stray currents were small enough to be overcome by the intentional polarization that occurs through the impressed current the repair contractor imposed). The third major contributor to the deterioration was the age of the structure itself.

Repair System Selection

For the $3.25 million project, the scope of work encompassed three main work areas: the intake floor, CWB, and SWP. To achieve the owner's goal, the team used an impressed current cathodic protection (ICCP) system to help prevent corrosion of the new and existing reinforcing steel in the floor.

Site Preparation

One of the major challenges for this project was that all work had to be performed while the plant was fully operational, as it was imperative that the plant maintain 100% power output. Foreign particles (that is, dust and debris) needed to be contained so they would not get into the motors, bearings, windings, and other mechanisms. In addition, the crew needed to be extremely careful while they were working in the vicinity of operating plant equipment. To achieve the required amount of protection, a number of systems were used. A protection net was installed to prevent water and debris from entering any equipment and panels. In addition, plastic walls were draped around the entire perimeter of each phase and were required to be watertight to prevent water and slurry from acting as foreign materials to panels, drains, and sumps. At all motor casing openings, frames were built to install filtering media to trap any possible dust so it did not get into the motor windings.

The setup of the protective area demonstrated the phasing and challenges of all the equipment that had to be worked around

Saw cutting of slots in CWB. Tight quarters made planning of the work critical to the success of the project

Hydrodemolition was used to remove the majority of the concrete and all hand-chipping was performed under heavily wetted conditions to minimize any dust. All debris was vacuumed out of the structure with state-of-the-art equipment. The water was pumped from the debris and neutralized to a pH level below 9.0 before being pumped back through the plant water treatment facility for final adjusting.

Repair Process

For the intake floor, an average of 6.5 in. (165 mm) of concrete was removed, a cathodic protection ribbon was installed, and a new concrete floor was placed to replace the old floor. With the CWB and SWP, concrete was removed to 1 in. (25 mm) under the reinforcing steel, a cathodic protection ribbon was installed, and the concrete was replaced. In areas where concrete was removed, the cathodic protection ribbon was installed at 12 in. (305 mm) on center and 1 in. (25 mm) above the reinforcing steel. The patches could then be formed and repaired with new concrete. In areas where the concrete was sound, the ribbon still had to be embedded into the concrete. To allow for proper ribbon placement, 1 x 2 in. (25 x 50 mm) slots were cut into the concrete, which then had grout placed over them. Approximately 3.5 mi (5.6 km) of saw cutting was required to install the ribbon in the concrete surface.

Placing the overlay on the intake structure floor presented other challenges. The ICCP system is 1 in. (25 mm) above the reinforcing steel and cannot touch the steel (this would result in a short of the system, which renders it useless). To overcome this challenge, the entire floor was decked with boards. As placement and finishing operations progressed, the boards were pulled up and removed from the work area. Additionally, the location of the concrete truck access in relation to the placement point exceeded 400 ft (122 m). This required a concrete mixture design that used ice, retarder, and plasticizer to ensure all placed concrete met strict NRC criteria.

The work schedule was also a major challenge as it was based on hours—not days—and all work was performed around trip-sensitive equipment (equipment that is designed to trip or shut down the reactors in the event of an emergency). Crews had to ensure that there was forward-thinking with each scheduled activity because all other groups and plant resources worked within the same schedule.

Because the repair work was in a nuclear power plant, there were several quality verification (QV) hold points. QV hold points require a third-party inspection and approval of a task prior to moving forward to the next task. QV hold points were used after demolition was completed to inspect the

Intricate scaffolding required to cut slots and perform concrete demolitions in SWPs

Anodes were attached with zip ties to a nonconductive spacer to keep it off the reinforcing steel, preventing shorting of the system

Project completion—Unit 2 of intake structure after floor coatings

condition of the existing steel. During this hold point, steel that had lost cross-sectional area was inspected to verify if it required replacement. A hold point was also required to inspect the replaced steel. The location of bar-locks, verification that all fasteners were fully engaged in the reinforcing steel, as well as identification of all deteriorated steel, was determined prior to placing the cathodic protection anode. Correct edge distances for all base plates also required a hold point.

All grout and bar locks used for the project required testing at an independent laboratory to ensure that all in-place material met or exceeded all physical data as shown on the technical data sheets. Grout was not placed until this data was returned for inspection and approved by the plant engineers.

Before, during, and after the concrete placement, the anode system ground to reference cell ground, reference cell to reference cell ground, and anode to system ground were tested for static potential via a multi-meter (mV static) and for resistance (ohms AC) via a soil resistance meter.

After the concrete placement, the cathodic protection system was also verified. A small current was impressed between the anode and reinforcing steel via a lantern battery to determine whether the system was polarizing. In all cases, the systems showed the ability to polarize, which proved the system was free of shorts. Another positive result was that 75% of the zones and sub-zones achieved full protection within 30 minutes of activating the permanent impressed current. Typically, this level is reached in about 2 weeks. The fact that this system achieved this level so quickly demonstrates a high level of consistency with regard to anode and cathode placement during installation.

The first phase of the project began in October 2006 and was completed in early 2007. Phase One represented approximately 15% of the project scope. The remaining 85% of the work (five phases) was completed between April and December 1, 2007, which shows a remarkable change in efficiency of the project when compared with the duration of the first phase.

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